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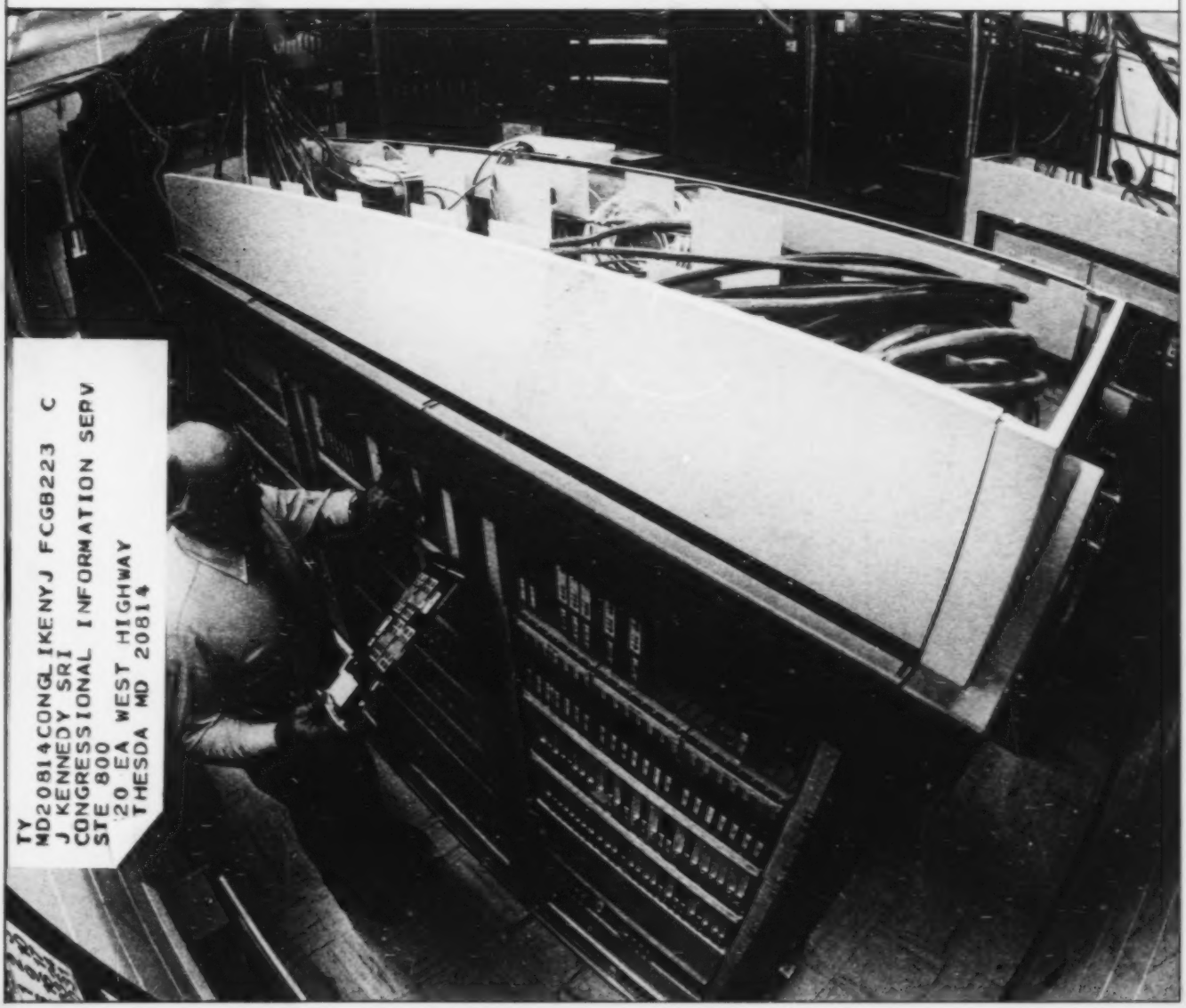
TOP NEWS: FCC orders refunds on AT&T's 1978 earnings, p.13
UTCI plans to buy Lightnet FO transmission systems, p.13
State, Commerce Depts. agree on telecom policy roles, p.14

Cover: The story of C&P Tel's digital installation in Virginia is one of three articles which discuss small systems, beginning on p.48



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telephony

News of the Week 13
FCC orders refunds on AT&T's 1978 earnings • UTCI plans to buy FO transmission systems • Eastman Kodak to enter telecom market

State, Commerce Depts. seek truce 14
In the Nation's Capital: FCC proposes guidelines for optional MTS • Washington Round-Up
Victor Block

U.S. 'no' to ISDN standards 47
Guest Editorial: The FCC's decision on ISDN created a partition which will likely inhibit introduction of new services
John C. McDonald

COVER STORY: C&P Tel's digital battlefield 48
C&P Tel has installed the first 5ESS switch host office and RSM in rural Virginia. Here are the results
F. M. Wichard

Voice mail improves efficiency 56
This article examines the features, architecture, installation, maintenance and upgrading of a voice mail system
Randall R. Pfeiffer and Sandra S. Pfeiffer

Digital PABX does double duty 64
Here's how Harris's Model D1205 supports operator services such as Centrex, alarm observation, paging, mobile and more
Thomas Lager

Are you ready for meet point billing? 74
The complex question of whether meet point billing should be allowed when end office billing is in effect is explored
Linda Myers

83 Indiana Bell cuts costs
Learn how Indiana Bell employes have increased their speed and efficiency while saving millions in operating costs
Debbie Lewis

88 Before bypassing, beware!
Although bypass technologies may offer advantages, there are major problems to be solved and pitfalls to avoid
Anthony Badalato

96 Divestiture and one independent telco
A look at what has happened to Contel's Eastern Region during the first 35 weeks following the breakup of the Bell System
Michael B. Esstman

104 Fiber optics for telephony
The second article in an exclusive five-part series continues the discussion of lightwave principles, sources, detectors and fibers
Doug Kulm

116 CCITT recommendations on the ISDN
An overview of the I-Series of recommendations on the Integrated Services Digital Network is given
Maurizio Decina

130 Long haul transmission costs
This article develops the estimated costs for three major long haul transmission media using voice-grade channels as the common basis for comparison

144 C&P Tel customers get options
Plant Man's Notebook: GTE/Florida donates FO exhibit to Tampa museum
Ray Blain

DEPARTMENTS

Advertisers' Index 188
Challenge and Response 190
In the Nation's Capital 14
Meetings 9
173 Moving Around Industry
147 New Products and Services
13 News of the Week
144 Plant Man's Notebook

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Before bypassing, beware!

ANTHONY BADALATO

BYPASS has received increased attention during the past several months and rightly so.

Spiraling telecommunications costs, lengthy installation intervals, uninspiring service levels and other industry developments have converged to fuel a growing telecommunications market segment.

Although many companies have installed or are contemplating bypass solutions for their communications networks, users should carefully consider several important issues before pulling the plug on the local telephone company.

'. . .companies in a number of fields will continue to find new and intricate ways to use telecommunications to gain an edge on the competition. Although telecommunications may not be the primary focus of a company, it has become a key . . .function that can no longer be ignored.'

Factors contributing

Bypass, as the term is used today, simply means the circumvention of the local telco's exchange network to move information to other locations in the same metropolitan area. While the concept and technical feasibility of bypass are not new, the technological springboard for the recent development of bypass was the introduction by Xerox Corp. of Digital Electronic Message Service (DEMs) in the early 1970s.

Xerox's plan was to accommodate a corporation's growing need to move information within a city and to provide access to long distance, or intercity services through very high capacity, high frequency microwave transmission facilities.

If the idea has been around for so long, why is there so much hysteria now?

Although the reasons for increased interest in bypass differ on a case-by-case basis, there are three major issues involved:

- Lack of options at the metropolitan networking level.
- Growing importance of telecommunications to business.
- Consumer dissatisfaction with existing systems.

Options

Communications networks generally can be topographically segregated into three levels: intrabuilding, metropolitan and long haul. Only recently have options at the metropolitan networking level responded to customer demands and expanding options at the intrabuilding and long haul levels. The metropolitan (across-town) connection, on the other hand, has become a bottleneck.

Primarily due to a combination of satellites, fiber optics and value added networks (VANs), long distance communication facilities have been in abundant supply for the past decade.

Satellites. With nearly 20 domestic satellites now operating and another 110 scheduled to be launched by the year 2000, a transponder glut is not difficult to envision. In addition, the increased sophistication and power of satellites and the diminishing size and cost of earth stations contribute to the increased viability and declining cost of satellite communications.

VANs. VANs continue to grow, both in terms of their number and of features offered. Tymnet and GTE Telenet, two of the longstanding sup-

Continued on page 92

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pliers, have been joined by new competitors, IBM and AT&T. Additionally, a plethora of features, such as sophisticated billing packages and protocol conversion combined with end-to-end error free transmission, will work to enhance the popularity and reach of these services.

Fiber optics. Optical fiber technology also has contributed to the wide array of long haul options. Communications carriers such as AT&T Communications, MCI Telecommunications and ITT Communications have constructed high capacity, long haul fiber networks. Southern New England Telephone (SNET) and United Telecom are committed to building large fiber optic networks to serve as alternatives to existing long-haul options. Other companies have formed consortiums to build nationwide networks that will offer transmission capacity to common carriers. For example, Southern Pacific Transportation, Atchison Topeka Santa Fe Railroad and Norfolk Southern are planning to build a system called Fiber Track that will stretch from coast to coast.

Traditionally, intra-building communications involved point-to-point wiring from host computers to data terminals and private branch exchanges (PBXs) to telephones. Although easy to accomplish, the method is generally wasteful and unorganized. Local area networks (LANs) offered by PBX, broadband and baseband vendors have enhanced intra-building connectivity to the point where user terminal moves and changes do not require cabling and moving information at megabit speeds is possible.

CO bottleneck

Faced with the growing capacities and options at the intrabuilding and long haul network levels and their increasing appetites for communications capacity, users were becoming frustrated with relatively pedestrian network options at the metropolitan level. It was difficult to match the capacity and sophistication of intrabuilding and long haul services with options available for the middle, metropolitan link. Users had to rely on facilities built predominantly to support voice communications. Thus, bypass options have been emerging. And, although telcos recently began offering high capacity, digital alternatives for metropolitan network connections, they remain expensive, difficult to obtain and are subject to lengthy installation intervals.

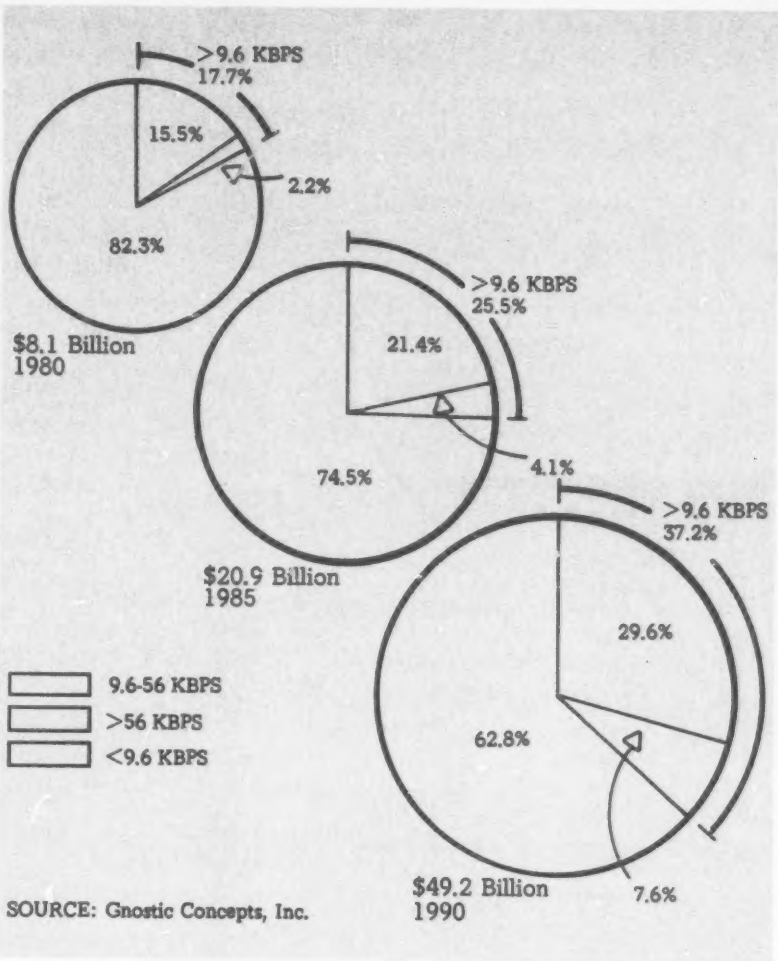

FIG. 1 *An illustration of the revenues expected to increase in high speed local services.*

Telecommunications plays an increasingly significant role in business today. For example, to remain competitive in retail banking, not only is it necessary to have attractive interest rates and competitive loan policies, but consumers also have come to enjoy the relative ease and convenience of automated teller machines (ATMs) which rely heavily on telecommunications services. The stakes appear to have increased again with the introduction of such at-home banking services as Chemical Bank's Pronto.

However, the battleground is not only in the banking industry and the broader financial services industry. Other sectors already profoundly involved include:

- Mobile cellular telephone, a technology still in its infancy, is being installed in Hertz and Avis rental cars in Chicago. Industry executives feel that the option of a mobile cellular telephone in a rental car may become as important as an air conditioner in attracting and retaining customers.
- Real estate developers are becoming increasingly interested in smart or communications-enhanced buildings. Smart buildings, a relatively new phenomena, offer prospective tenants the options of using (sharing) a building telecommunications infrastructure instead of purchasing and operating their own on an individual basis. Some of the services available in smart buildings include shared telephone systems, bypass microwave facilities and intrabuilding data communications. Real estate developers such as Olympia & York, Lincoln Properties and Tishman Realty recognize the value of constructing smart buildings to attract and retain tenants, and perhaps to generate incremental revenue and profits.

Clearly, companies in a number of fields will continue to find new and intricate ways to use telecommunications to gain an edge on the competition. Although telecommunications may not be the primary focus of a

Continued on page 94

company, it has become a key support function that can no longer be ignored.

There are companies in New York City and elsewhere waiting 12 months and longer for high speed, high capacity T1 circuits from local telephone companies. Who can afford to wait a year in these turbulent times? At the same time, demand for high speed services above kilobits per second (kb/s) has increased. Gnostic Concepts projects at an average compound annual growth rate of more than 22% (Figure 1).

Bypass provides an option that many companies in New York City have been quick to adopt. For instance:

- Citibank has installed a fiber optic network under Manhattan to connect its midtown headquarters with offices in three downtown locations. The company also uses microwave transmission to handle interoffice calls within Manhattan.
- Morgan Guaranty, another New York financial institution, also uses microwave links to connect buildings in lower Manhattan. In addition, it relies on a Manhattan Cable TV-constructed private broadband network between two of its locations for added capacity and redundancy.
- And, irony of ironies, both AT&T Information Systems and Nynex recently submitted bids to a large financial institution in Manhattan for the constructior of a high capacity, fiber optic network that would bypass the embedded local exchange network.
- Izod Ltd., a subsidiary of General Mills, has turned to Local Area Telecommunications, a New York City company that moves voice and data over local microwave facilities, to communicate information between two buildings just five blocks apart. Local Area Telecommunications' edge is its rapid installation time, which can be as short as a week. Alternatively, many companies are using Manhattan Cable TV's public network, which offers data communications speeds between 1.2 kb/s and 1.544 megabits per second.
- New York City's Teleport project represents another major bypass development, although still years away from completion. Merrill Lynch, Western Union and the Port Authority of New York and New Jersey have teamed up to build the $225 million office park and communications center. Located on Staten Island, Teleport will offer users direct access to 12 or more satellites through an antenna farm at Teleport's Staten Island site. The Staten Island office and communications complex will be connected to business users in Manhattan and New Jersey by fiber optic cable, providing even more competition for the metropolitan communications market.

Bypass options are multiplying while interest continues to grow. Users want to quickly satisfy their appetite for communications capacity and flexibility with the kinds of service options available to them at the less regulated, more competitive long distance and on-site network levels. Users want to control the financial and technological evolution of their networks, a goal which bypass can help them attain.

Although many of the larger and more experienced companies are using bypass, a recent poll taken by the International Communications Assn. (ICA) of its members, which are mainly large corporations, reveals that there may be more smoke than fire. Gauged to assess the extent and dangers of bypass to the local telco offices, the survey showed "there is no bypass problem that endangers carriers or universal services, either now or in the foreseeable future." The survey also indicates that customer bypass is perhaps a "less significant factor in the overall telecommunications industry than previously asserted."

Some 29% of the ICA members surveyed now use some type of bypass facility. About 60% said that the use of bypass facilities would not provide an adequate option for most users at most locations. About 66% of those considering bypass have not yet reached a decision requiring major economic commitments. A recent example lends support to the findings of the ICA study.

'Bypass. . .simply means the circumvention of the local telco's exchange network to move information to other locations in the same metropolitan area.'

One decision

A major New York financial institution, along with Coopers & Lybrand, recently studied ways to enhance its New York City interbuilding networking using bypass as a consideration. In this case, the bypass alternatives were simply not feasible for many reasons, some of which were:

- Private network construction charges were extraordinarily high.
- Direct line of sight for microwave use was obstructed. The use of additional repeaters would be expensive, due to the high cost of renting space atop buildings, and increase exposure to network failure.
- Other intracity communications carriers were more expensive or offered less capacity than the eventual supplier, New York Telephone.

In many cases such as this, local telcos, aware of competitive pressures, have multiplied their options and adjusted their rates. Many of the Bell operating companies (BOCs) have filed or plan to file tariffs to offer end user, high capacity T1 facilities. Also, many telcos plan to replace aged facilities with fiber optics. In addition, BOCs are rapidly installing digital central office switching; projections suggest that 90% of local and metropolitan transmission lines will handle digital traffic by 1990.

Considerations

There are clearly real opportunities available with bypass solutions. However, there are potential pitfalls that should be examined thoroughly before altering a company's networking course. They include:

Staffing. Does the organization have enough qualified people to understand and support the new network approach? For example, the technology of a broadband-based network is altogether different from that of an analog network.

Vendor. Has the vendor ever done this before? What type of back-up support can it provide? Does it have a solid reputation in the industry? Many vendors, realizing the opportunities available, are expanding their horizons into providing bypass services. However, sometimes the maintenance and support facilities, such as on-site maintenance, and network

Continued on page 172

The breakup of AT&T: one Independent's view

MICHAEL B. ESSTMAN

THE FEDERAL government greeted the new year on Jan. 1, 1984, by dismantling the Bell System, the organization that served as the backbone of the national telephone network.

Since then the average American has come to realize something. The telephone network is not ordinary. Divestiture has shown the public there is more to telephone service than just that unassuming device that sits on their table-tops and adorns their walls.

People are beginning to understand two things. The telephone network may be unassuming, but it is as valuable as oil in the ground. Second, by breaking up the Bell System, much more has happened than just settling an antitrust suit.

The decision to divest the Bell System is the culmination of a trend that began in the 1950s and has now brought the access era. Divestiture lies on a plan where several disciplines intersect: communications, economics, law, social science, politics.

What has divestiture meant to the Independent industry?

This article will discuss what has actually happened this year to one company, Continental Telecom, from the standpoint of three items: mechanics, revenue, operations.

Contel's Eastern Region mirrors many Independent operations. It is made up of large and small companies that operate in rural and urban surroundings in 13 states.

The world of long distance service has been rearranged: from who provides it, to who is responsible for the costs and how those costs are recovered. It is a multi-billion dollar conversion for a multi-billion dollar business.

The industry had perfected a tidy system to deal with long distance revenues before divestiture: separations and settlements. There were four basic steps: First, traffic studies were made. Each year roughly 33% of telco exchanges were tested for usage. Local calling and the amount of intrastate and interstate toll calling were tested. From these tests traffic factors were developed. Using these factors, telcos divided investment and expenses into three categories: local, intrastate toll and interstate toll. This separation resulted in step two of the process, a cost study. The bottom line of the study, of course, represented the toll revenue requirement. Telcos did this once a year.

In step three, the cost studies were then filed for review and approval with the Bell operating company (BOC) with whom the Independent connected. Step four is the settlement itself. The Independent sent the BOC all the toll revenues that were billed and collected, and the BOC paid the Independent the settlement. That settlement was recorded as toll revenue on the Independent's income statements, and it was based on the BOC's achieved rate of return.

The toll revenue requirement the Independent received was based on traffic volumes, the investment and expenses that the Independent assigned to toll in its cost studies and the BOC's achieved rate of return. In turn, the BOC would reflect the settlements as an operating expense. The BOC used that level of expense to set toll rates. All the toll revenue that was billed and collected was reflected as revenue on the BOC's books.

Lots of paperwork and labor were involved, but this system served the industry and the country well for decades. The settlements process made the national telephone network second to none and achieved the universal service goals set by the Communications Act of 1934.

Since divestiture, this world has not only been rearranged, it has been fired up to a new orbit. The industry has been given its marching orders: less regulation and more competition. Accordingly, instead of settlements, the industry has been rocketed into an access charge arrangement. Telcos still do traffic studies and cost studies. But that is where the similarity ends—and even that is not quite the same.

First, telcos are responsible for tariffs that spell out all the access and related services provided toll carriers, along with the price of each. Telcos also must bill the carriers on a monthly basis, and collect access revenue on a monthly basis.

For 1984, Contel has joined the National Exchange Carrier Assn. (NECA) to carry out the procedure. Through NECA, Contel follows industry-wide access charge tariffs and pools access charge revenue with the other members.

Obviously the number of players in the long distance market has increased considerably. Instead of sending one cost study to one carrier once a year, Contel is billing AT&T every month and still settling with the BOCs. And the company is dealing with a new entity, NECA. If and when Contel decides to develop its own interstate access tariffs, then the Federal Communications Commission (FCC) also will become a participant.

But, of course, this is only half the picture. The access arrangement just described concerns only interstate toll traffic. How the intrastate toll revenue requirement is recovered depends on the specific access plan for each state.

Local access and transport areas (LATAs) are intended to mark off the BOCs' domain for long distance within each state. But from a pro-

Continued on page 98

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cedural standpoint, LATAs actually create states within states. At last count there were 161 LATAs. Traffic between each must be handled by AT&T or some other toll carrier. Contel, therefore, must charge for access services using tariffs approved by the state regulatory bodies.

Some states pool this access charge revenue. Others generally use a so-called bill-and-keep method. Still others are combinations of the two, depending on whether the traffic stays inside one LATA or crosses into another. There are 10 states in Contel's Eastern Region that require access charge tariffs, and there are four distinct state plans.

To summarize, the old system required Contel to deal only with the BOC to recover its toll revenue requirement. To accomplish the same thing under divestiture, Contel is working with NECA, the BOCs, AT&T and its competitors, various state plans, and, eventually, it will work with the FCC. And more than 60% of Contel's revenue came from toll revenue.

What about the revenue itself? What effect have divestiture and access charges had on the company's toll revenue streams?

Contel joined NECA in 1984. The company's revenue to a large extent depends on NECA's achieved rate of return. In May, the FCC authorized a set of access charges that, together with volume forecasts, were designed to produce the returns for NECA members shown in Table 1. Based on the same access charges, but different volumes, NECA forecast the returns shown in Table 2. The preliminary, unofficial returns for June, July and August based on data submitted to NECA by its members are shown in Table 3.

As Table 3 clearly shows, there are some serious deficiencies. In Contel's Eastern Region, a 1% change in rate of return is roughly equal to about $4 million in revenue.

It is impossible to specify a single determinent for the deficiency: the problem is too complex. But the deficiency generally is related to usage. Most of this year's revenues are based on projections of investment and expenses along with usage. At this stage, it is becoming obvious that the actual minutes of usage are less than had been projected.

Furthermore, it appears the drop in AT&T's long distance rates had not resulted in the expected increase in calling volumes. When AT&T was ordered to cut its rates by 6.1% everyone assumed that calling volumes would increase. In fact, calling volumes were expected to go up by 13.5%. But the demand has gone up barely half of the anticipated amount; the expected calling volumes just have not materialized.

Table 1
FCC forecast

Non-traffic sensitive: 11.0%
Traffic sensitive: 13.3%
Billing and collection: 12.75%

Table 2
NECA forecast

Non-traffic sensitive: 8.4%
Traffic sensitive: 11.1%
Billing and collection: 12.75%

Table 3
Actual returns

	June	July	August
Non-traffic sensitive:	8.42%	9.79%	9.99%
Traffic sensitive:	9.36%	10.16%	11.51%
Billing and collection:	(-0.8%)	1.09%	1.37%

As expected, the returns for intraLATA toll are below historic intrastate levels. This was expected because of the nature of the short haul toll business: Short haul toll is less profitable than long haul toll. The divestiture left AT&T with the longer routes, while the BOCs generally have the shorter haul, higher cost toll business.

The interLATA portion is much more complex. In some states, Contel is doing very well, while in others the returns are less than satisfactory. The level of returns is related to two factors: the cost of providing that service and the fact that the interLATA tariffs in most of the company's states mirror the NECA tariff.

NECA rates are based on nationally averaged costs. But the costs in individual states can be above or below the national average. Therefore, where the cost of providing service is above the national average, the returns are deficient, and where the cost is below the national average the returns are good. Both conditions prevail in Contel's Eastern region.

Many states are now working to develop their own specific plans for interLATA toll; bill-and-keep is where most of them seem to be headed. But this tendency points once again to the need for correctly forecasting usage.

Figuring out how much the network is used seems like something a telco could deal with handily. But it is not so easy. The problem is rooted deeper than first imagined.

Consider, for instance, what a minute-of-use means to the telco and what it means to customers. There is a difference. There are seven components to a telephone call: off-hook, the end office dials the digits, customer acknowledgement, switching, answer supervision, the conversation and disconnect.

As far as customers are concerned, the minutes-of-use are in the actual conversation time. But the minutes-of-use the telco recognizes with access at the customer acknowledgement component. Access begins much earlier than the conversation: after the customer finishes dialing and the call switches through our network. Actually, access is provided even if the customer gets no answer or finds the line is busy.

Obviously, telcos need to perfect capturing and calculating how much the network is used. The distinction between a conversation minute and an access minute is one example of the problem. Measuring terminating usage is another. In the future all access tariffs will be based on forecasted access volumes in addition to investment and expenses. This goes for interstate and intrastate traffic.

When telcos reach that stage, there will not be a chance to backtrack a year later, file a cost study, and correct estimates or allocations. Any revenue shortfall will be lost forever. There is much more revenue opportunity under this system, but it is also much riskier than the settlements system. What telcos bill is what telcos will get!

This point is critical. The oppor-

Continued on page 100

tunities everyone in the industry believes are open will not materialize unless telcos can account for every minute of access. In fact, that will be telcos' business in the future: selling access to subscribers and carriers.

The industry has always placed a lot of emphasis on accurately forecasting investments and expenses. It now needs to place the same emphasis on usage.

End users

The discussion thus far has focused on access charges as they apply to toll carriers. But there is the other, more politically volatile side of this phenomenon: access charges for subscribers or end users.

Many people have strongly opposed the very concept of customers paying interstate access charges. One school of thought claims the charges will erode universal service. Others contend the charges are just plain unfair, that a flat rate fee is improper, even if customers originate or terminate interstate toll calls. Still others criticize the charges on jurisdictional grounds. By proposing end user charges, critics say the FCC has wrongly assumed *de facto* regulation of local rates.

The controversy over this issue has risen to the highest political levels. Everyone concerned has seen the evidence, as time and again the FCC has found it necessary to review its proposals. Right now the FCC is still at an impasse over even the most basic issues.

The debate on end user charges is counterproductive. The toll carriers currently are paying access charges for telcos' non-traffic sensitive plant. By 1990, however, those payments will cease and those carriers will only be responsible for funding a small pool to cover the so-called high cost telephone companies.

If this sounds familiar it is because the industry is still on a course leading straight toward Pure II, a situation which is inequitable. Subscribers and toll carriers are both users of the local network, and each should pay its fair share of the costs.

To its credit, the FCC at least recognizes the political difficulties and is open to suggestions.

The FCC's goal, of course, has been to develop a more equitable system of cost allocation, a system that is consistent with the deregulated, competitive environment the commission has encouraged. To that end, the long standing practice of allocating non-traffic sensitive costs to interstate toll must come to an end quickly. That system, according to the FCC, is just too arbitrary. The big culprit here is the subscriber plant factor. But whatever is changed, it must all be accomplished without sacrificing universal service or promoting uneconomic bypass.

Contel believes the best way to meet this goal is to gradually replace arbitrary methods with methods that are more factual; that is, to replace subscriber plant factor with something that can be based solely on usage.

This usage sensitive factor should be applied to allocate all non-traffic sensitive costs. This factor is identical to the subscriber line usage factor, but Contel calls it the exchange network usage factor, or ENUF.

Frankly, Contel believes that ENUF would be enough! Unlike the Pure II arrangement, carriers would pay a portion of telcos' non-traffic sensitive plant under that telcos' ENUF plan. But Contel's tests with the formula show the costs would still drop significantly. The costs would not drop down to zero as Pure II would have it, but they would be low enough to encourage competition and effectively counter the threat of bypass.

The result of such a move, of course, means some revenue requirement would be transferred to state jurisdiction. But that is exactly where Contel believes the responsibility should be.

Not everyone benefits equally from technology and competition—especially people who live in more sparsely populated regions. In those areas, the states and the local telcos should be able to assign costs and set rates that reflect the particular economic circumstances. With an access plan based on usage, this could be accomplished.

For example, the likelihood of bypass and the degree of universal service needs could be taken into consideration through combinations of local rates and carrier fees. This kind of system would provide flexibility. In addition, there are provisions within Contel's overall plan for limiting what would be transferred to state jurisdiction per year. The current high cost formula also would be maintained.

But, most importantly, ENUF precludes the political debate over interstate end user access charges. The FCC has said in the past that an end-user fee "is an equitable and economically sound method for recovering a portion of non-traffic sensitive costs." But Contel believes that fee has always been an implicit part of the basic exchange rate. Right now at least, connection to the local network is the same as connection to the toll network. In practice, there cannot be one without the other.

Based on that principle, ENUF puts those costs right where they belong: under state jurisdiction. By using the ENUF formula, those non-traffic sensitive costs will be recovered through state rate adjustments. Therefore, there would be no need to go beyond the ENUF plan and levy an end user charge.

How has divestiture affected Contel's operations? The company's old Settlements Dept. in the Eastern Region has grown from a staff of 19 people to a staff of 33 people. And the department now is called Intercity Revenues Dept.

This growth is also reflected further down the line. Each of Contel's five divisions has set up Network Access Bureaus. These men and women serve as the company's link to toll carriers, state commissions and connecting companies.

Network planning is another area that has taken on a new role. Sooner or later, the existence of more than one toll carrier should stimulate use of the network in some areas. But where will Contel provide equal access? What network configuration would be best for each office that converts? Where will access tandem switches be needed? Right now Contel is studying many areas in anticipation of precisely these kinds of changes.

As far as traffic between LATAs, AT&T retained its operator services. AT&T wants that business on its switchboards. But intra-LATA traffic is another matter.

Independent companies may have the choice of staying in the business, or paying someone else to do it. Contel is looking at its operator centers very closely.

Finally, there are the telco's customers. They are seeing some prices go up, and they are hoping that some prices will come down. The jury is still out on that last point, but certainly there is more variety and choice available to customers now.

But there is also room for more confusion, so it is understandable that customers get perplexed from time to time. Getting a telephone installed or repaired is a little more complicated, and some people are

Continued on page 171

Long haul transmission: a cost comparison

THE CONTINUING improvement of old technologies and the emergence of new methods have combined to produce a wealth of choice for long haul transmissions of voice, data and video.

While the choice may be constrained by physical factors, in many cases the critical items will include cost as a major factor.

A communications system designer has a tremendous variety of technologies from which to choose depending on the specifics of the desired system. The boundaries between the appropriate areas for these technologies are not sharp; in fact, a complete system will often use several of them. Table 1 shows some of these current technologies and gives a brief synopsis of their areas of best applicability.

This article concentrates on the long haul portion of the communications system, so some of the communications technologies listed in Table 1 are not examined in detail. These technologies will often be used for local distribution at the terminals of the long haul links. The three major technologies that this article is concerned with—geostationary satellites, terrestrial point-to-point microwave and optical fiber cable—have more or less defined areas of competence, depending on the length and density of the link, as well as other features. Remember, however, that the boundaries of these areas change with changes in technology and relative costs among the three techniques.

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Satellite systems

Geostationary communications satellites have been providing domestic transmission services to the United States since 1974, and account for a growing share of the domestic long haul market. A typical C-band satellite transponder on a U.S. domestic spacecraft has a radio frequency (RF) bandwidth of 36 megahertz (MHz) and a radiated power of 34 decibels referred to 1 watt (dBW); this has been used as a standard reference in this article, although other bandwidths and higher power levels are being placed in service. Transponder capacity can be scaled by bandwidth, if adequate power is available. Scaling for power increases is more complex.

The use of a reference transponder provides a reasonable standard for comparison, since many carriers will continue to use 36 MHz or a multiple thereof, and power levels are not in-

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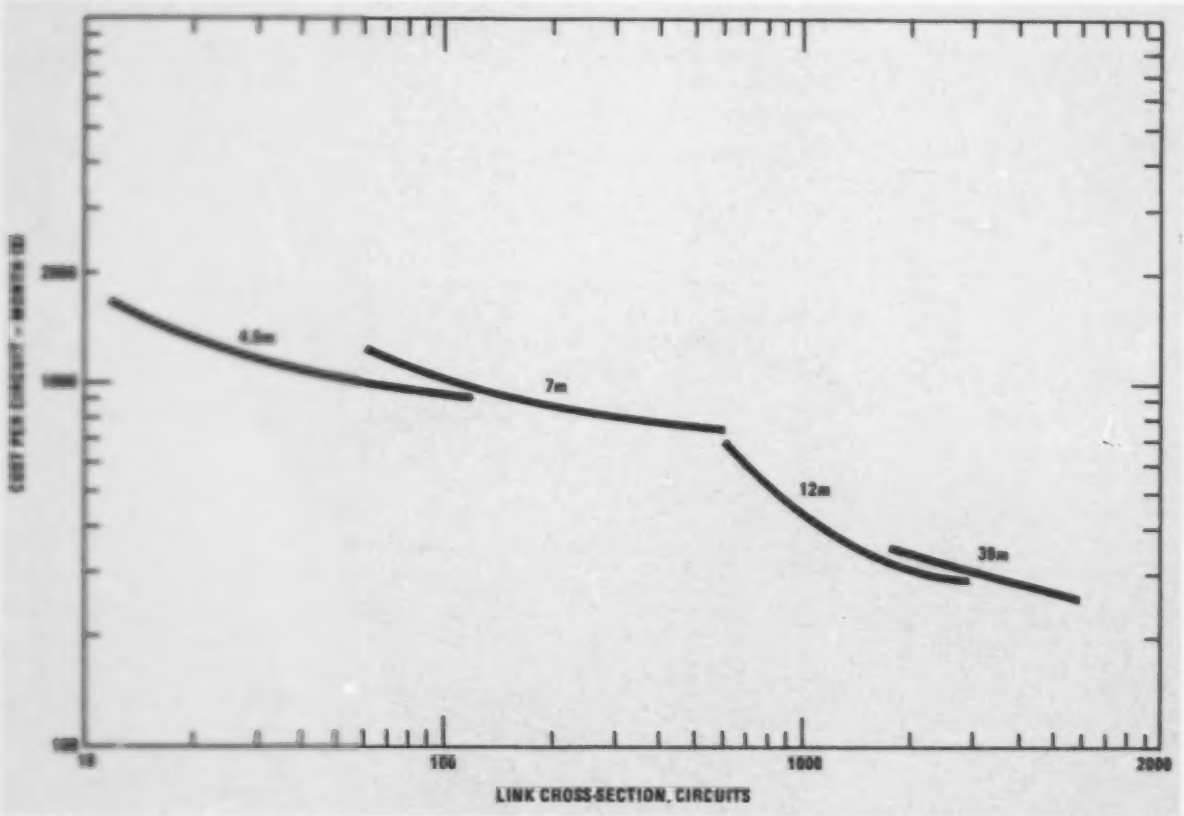

FIG. 1 *Cost per circuit—month for companded FDM/FM satellite circuits.*

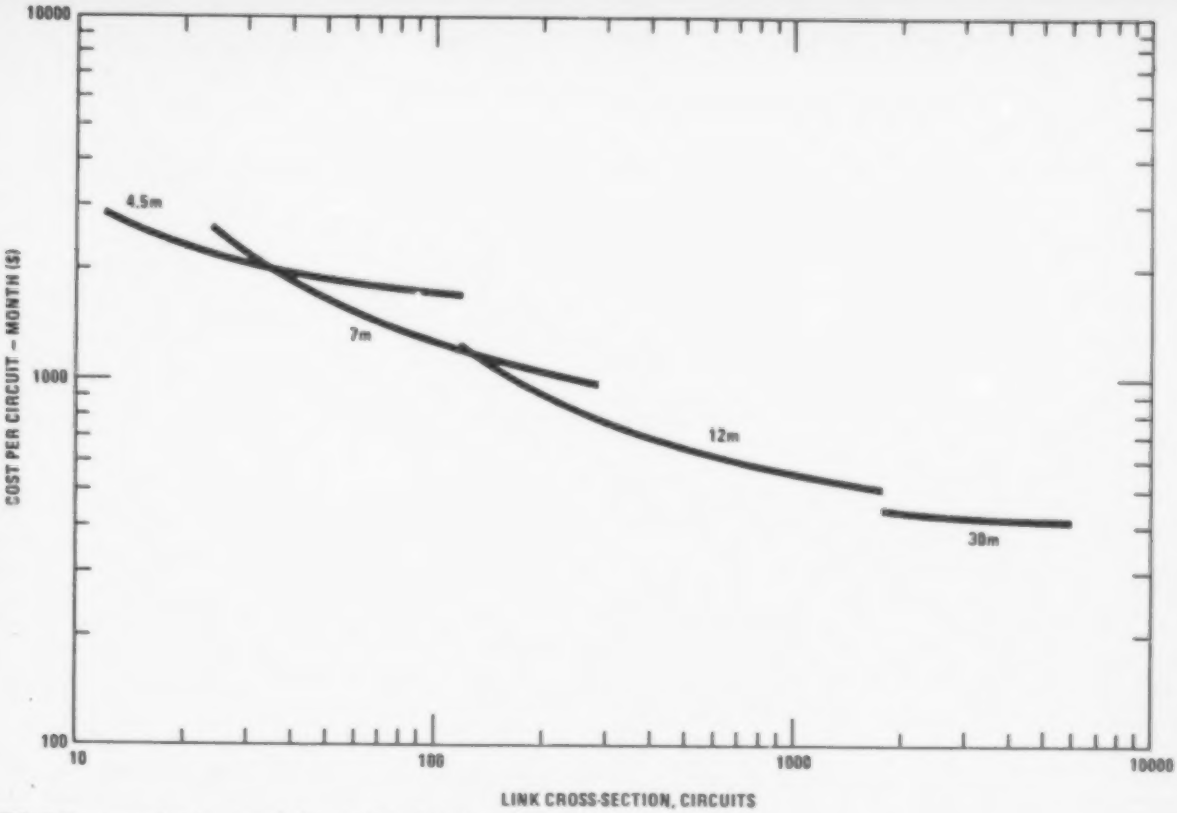

FIG. 2 *Cost per circuit—month for satellite TDMA and TDM.*

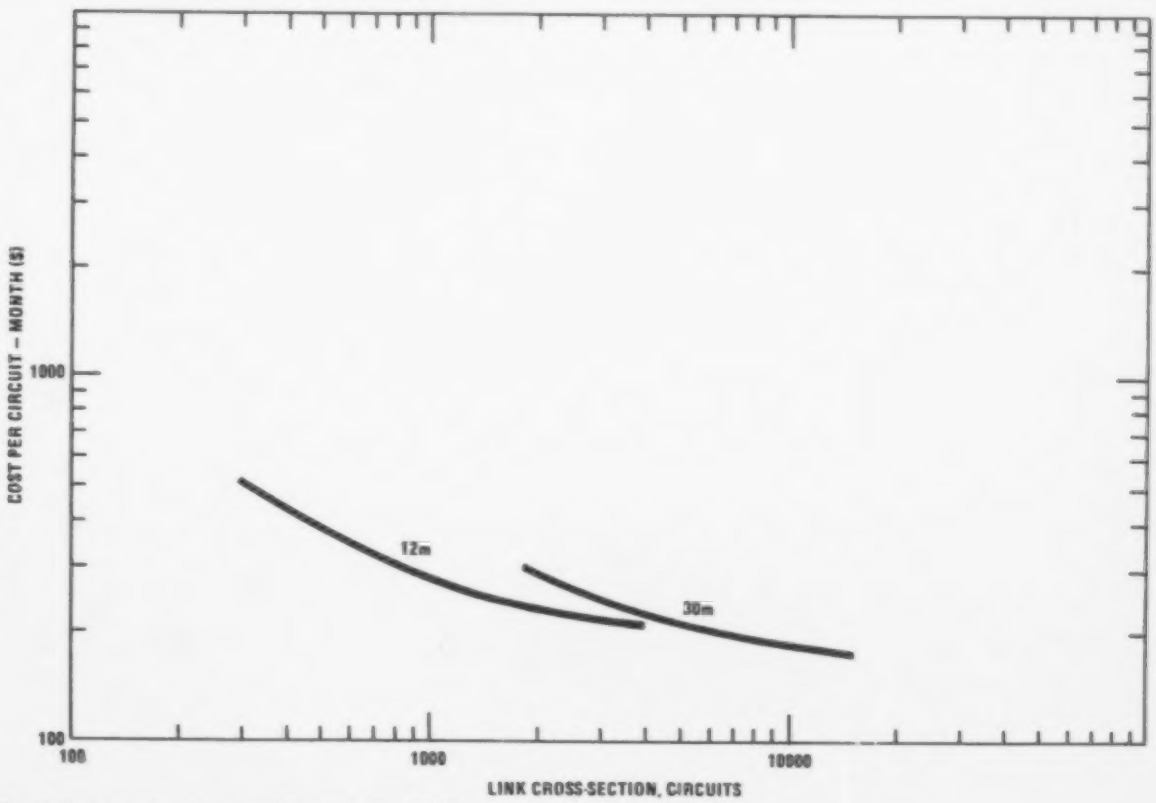

FIG. 3 *Cost per circuit—month for satellite CSSB.*

creasing rapidly, although they are changing.

Transmission costs have been developed for a range of earth station performance criteria and modulation/access methods.

The performance parameters of the earth stations used as examples are shown in Table 2. In many cases, larger earth stations are already in service in the United States, but the general trend until recently was toward the use of smaller antennas and less expensive station configurations.

Last year's decision by the Federal Communications Commission (FCC) to reduce spacing between satellites to 2° will curtail significantly the use of smaller antennas. A new antenna standard, 3 decibels (dB) more stringent than the previous standard, was also part of the decision. A 4.5 meter (m) or smaller antenna at C-band may very well be unable to meet the new criteria on a production basis. At Ku-band or 30/20 gigahertz (GHz) or Ka-band, small antennas will have no trouble meeting the standards.

Another concern which will affect the use of smaller stations is the recent flap about spectral efficiency. While such modulation schemes as companded single sideband (CSSB) do result in more efficient use of spectrum, they also require larger stations. Any undue emphasis on spectrum-efficient schemes tends to discriminate against the smaller station.

The general trend to smaller stations will continue because many users want and need them. Even uses which are quite spectrum-inefficient will be offered, taking advantage of the market which opens when a low cost facility is available.

The modulation/access methods used are:

- CSSB with either single or multiple access;
- Frequency modulation (FM) using frequency division multiplexing (FDM) and either single access (single carrier per transponder) or multiple access (multiple carriers per transponder); and
- Digital phase-shift keying (PSK) modulation, using either a single carrier per transponder/single access, or a single carrier per transponder/multiple access (TDMA) configuration.

For FDM/FM systems, an evaluation has been made for both companded and uncompanded signals; companding can significantly increase the number of channels per carrier. The digital systems were evaluated both with and without digital speech interpolation (DSI). Use of

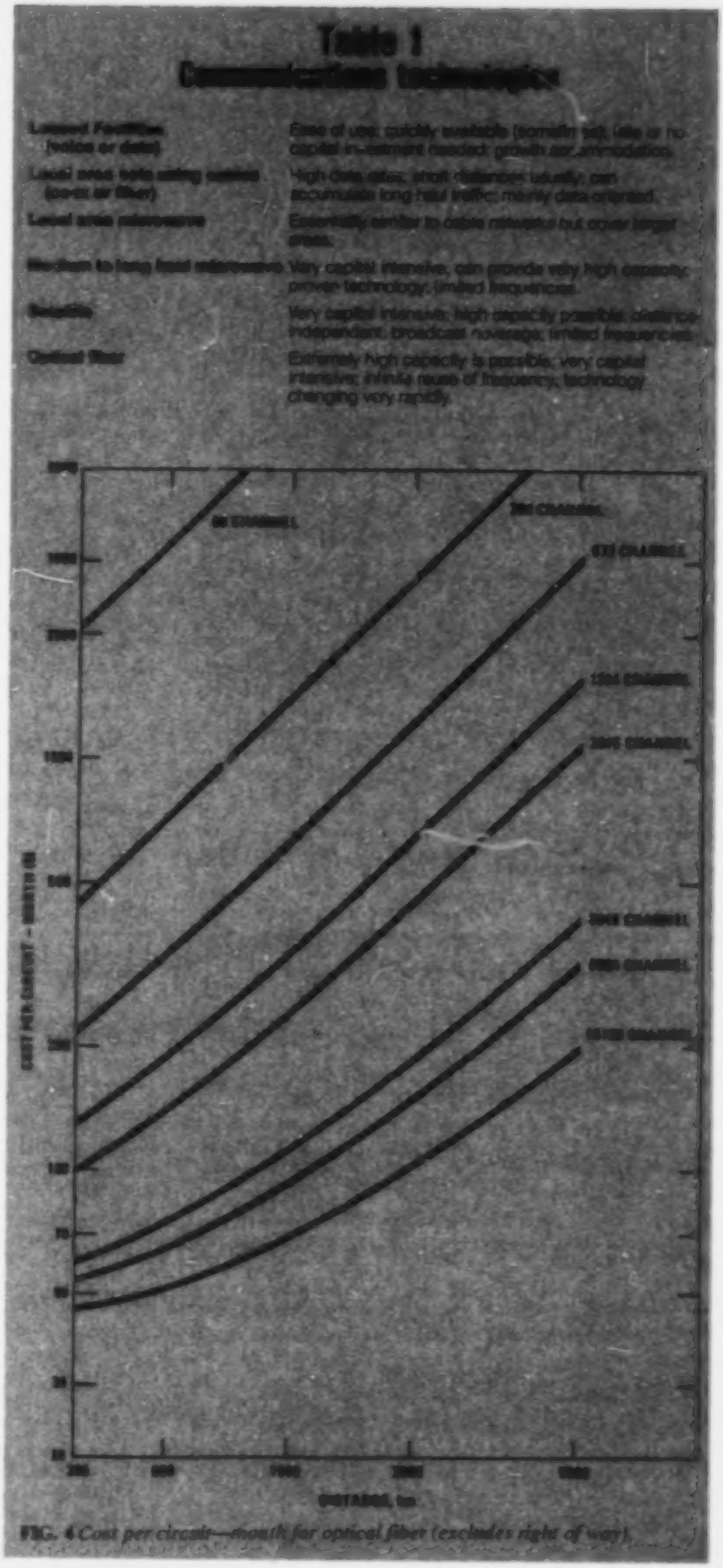
Table 1
Communications technologies
Leased facilities (voice or data)
Ease of use; quickly available (some in set); little or no capital investment needed; growth accommodation.
Local area, table setting system (Ku-or Ka-)
High data rates; short distances usually; can accumulate long-haul traffic; mainly data oriented.
Local area microwave
Essentially similar to cable networks but cover larger areas.
Medium to long haul microwave
Very capital intensive; can provide very high capacity; proven technology; limited frequencies.
Satellite
Very capital intensive; high capacity possible; distance-independent; broadcast coverage; limited frequencies.
Optical fiber
Extremely high capacity is possible; very capital intensive; infinite reuse of frequency; technology changing very rapidly.
COST PER CIRCUIT – MONTH ($)
DISTANCE, km
FIG. 4 *Cost per circuit—month for optical fiber (excludes right of way).*

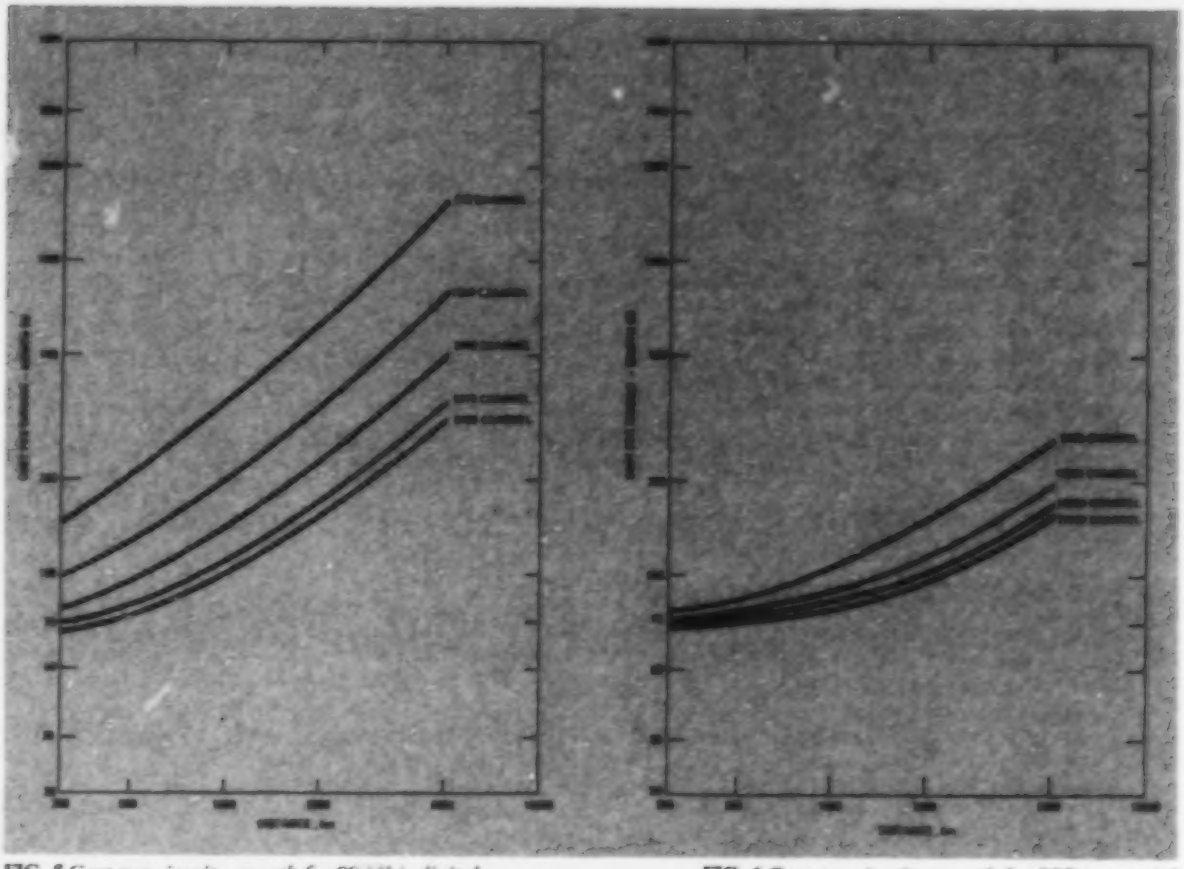

FIG. 5 *Cost per circuit—month for 90 Mb/s digital microwave radio.*

FIG. 6 *Cost per circuit—month for SSB terrestrial microwave.*

DSI can double the capacity of a carrier loaded primarily with voice traffic. Figure 1 shows the cost per circuit per month for companded FDM/FM satellite circuits; Figure 2 for satellite TDMA and TDM; Figure 3 for satellite CSSB.

Since, within the visibility of the satellite, costs are distance insensitive, the only variable is the number of channels carried by the earth station.

Optical fiber

During the past few years, optical fiber technology has developed from the point of experimental and trial installations to standard commercial offerings. Optical fiber offers five primary advantages:

Large bandwidth. Bandwidth is the information carrying capacity of the transmission medium. Fiber optic bandwidth is specified as a function of distance. The typical bandwidth in graded-index fibers ranges from 400 MHz per kilometer (km) to 1000 MHz/km. A 0.25 in. diameter cable containing two optical waveguides can carry the same volume of communications as a 3 in. diameter communications cable containing 20,000 copper wires.

Table 2
Example earth station technical characteristics

Antenna diameter (m)	4.5	7	12	30
LNA temperature (K)	200	100	40	40
G/T (dB/K)	21	25	34	42
Transmit gain (dB)	48	51	55	62

Small size, low weight cable. Optical fiber is quite compact for a high bandwidth system. Optical fibers are mere strands; the core diameter can range from 250 micrometers to 5 micrometers for the single-mode fiber. The size advantage is augmented by a weight advantage. After it is fully cabled for protection, the waveguide often weighs less than 25 kilograms/km.

Low loss. Laboratory results have yielded signal attenuation as low as 0.2 dB/km in single-mode silica fibers. The attenuation is dependent on both the fiber type and the wavelength of the light source. Older optical fiber systems transmitted in the short wavelength range, of 850 nanometers (nm), and featured losses on the order of a few decibels per kilometer. Systems are currently available which transmit the longer wavelengths, 1300 nm, and feature a lower loss, less than 1 dB/km. Attenuation will be reduced even further with future developments in the 1500 nm to 1600 nm band.

Noise immunity. Because the fiber waveguide is totally dielectric, it is immune to induced noise, whether in the form of electromagnetic interference, radio frequency interference or electromagnetic pulse.

Electrical isolation. Optical waveguides, because they transmit via photon emission, are immune to electromagnetic interference from lightning, power line noise, corona

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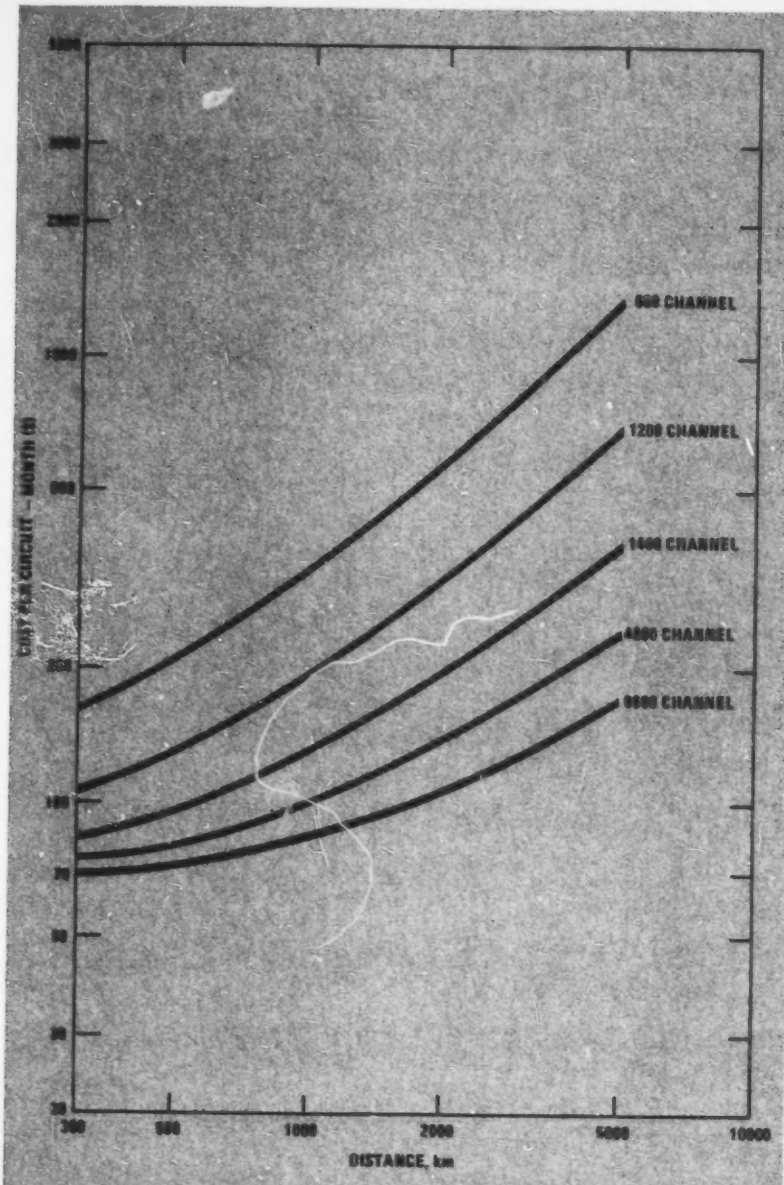

FIG. 7 Cost per circuit—month for FDM/FM terrestrial microwave.

Table 3

Fiber optics costs per km (1984 dollars)

	Transmission rate (Mb/s)			
	180	405	575	1150
Number of fibers	4	4	4	6
Cable cost	2050	2050	2050	3075
Cable installation	10,000	10,000	10,000	10,000
Repeater (50 km spacing)	480	480	480	720
Total	$12,530	$12,530	$12,530	$13,795

The cost is based on a 100 km reference path; it does not include terminal electronics or MUX.

discharges and other interference sources. As a result, fiber cables can be used to transmit across high voltage potentials.

In addition to those advantages listed, fiber optic systems are resistant to intrusion and, therefore, can be used for secure transmission. Table 3 shows the installed optical fiber cost per kilometer. Figure 4 shows the calculated cost per channel as a function of distance and the cable capacity.

Costs for fiber systems will vary widely, since they are highly dependent on the cost of installation. The figures shown for installation costs are probably low in urban areas. Costs of over $40,000 per mile are entirely possible in major cities. Because of this factor, there will be few, if any, fiber systems with moderate or low capacity. The trend will be to install a large number of fibers at once, even if little is used immediately.

Microwave radio

The most mature technology of those examined in this piece, radio relay systems, has been carrying long distance telephony since the late 1940s. While much existing equipment uses FDM/FM, there is a trend toward the use of digital radio in new and replacement systems. Figure 5 shows the cost per circuit per month for 90 megabits per second (Mb/s) digital microwave radio; Figure 6 for single sideband (SSB) terrestrial microwave; Figure 7 for FDM/FM terrestrial microwave.

In order to provide an informative cost comparison among the three transmission methods, the costs for variations in channel capacity on the link and connection distance of the link have been computed. The satellite case, of course, is invariant with distance. Figures 8, 9 and 10 present the comparison for distances of 100 km, 500 km and 3000 km, respectively. The relationship between microwave radio and optical fiber remains about the same through these variations, as would be expected since they are both terrestrial techniques. At the larger distances, the advantage of the satellite system can be discerned.

Figures 11, 12 and 13 show the comparison as a function of distance for capacities of 60, 600 and 6000 voice circuits per link, respectively. These figures illustrate the fact that satellite circuits are best for relatively long, lightly loaded links, and optical fiber

Continued on page 141

systems for shorter and heavier links, with microwave falling between them over a broad range.

Local distribution

Because of the limited data rates supportable within the voice-grade telephone plant for local distribution, and the need for alternative systems to interconnect automated business machines, several alternative local distribution systems have been developed. Some of these systems, primarily designed for service to automated business machines, use coaxial cable or optical fiber cables for limited distance, relatively low data rate connections.

More recent developments in low cost microwave, using packet system access techniques and the 10 GHz band, have resulted in a number of applications for construction being filed with the FCC. These digital termination systems (DTS) promise to furnish a relatively inexpensive interconnection for data users that can be employed for local communications or connection to satellite earth stations for long haul data transmission.

Other considerations

Other issues relating to transmission cost which concern potential users are the introduction of low cost earth stations and the use of multi-beam and hybrid satellites. These tech-

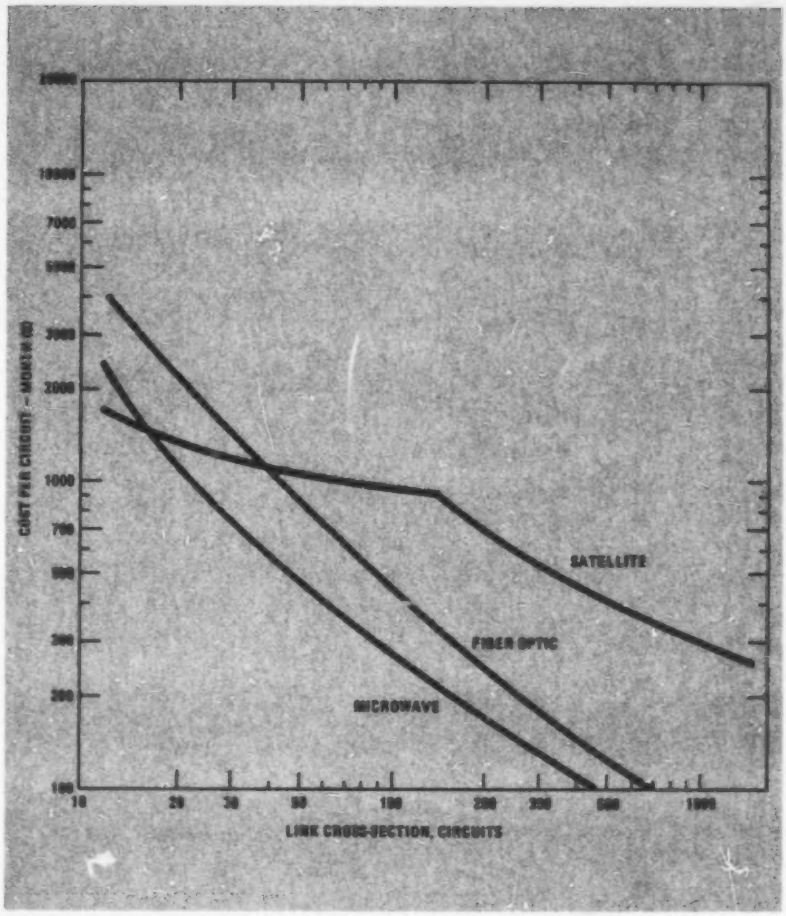

FIG. 8 *Cost per circuit—month vs. link cross-section length = 100 km.*

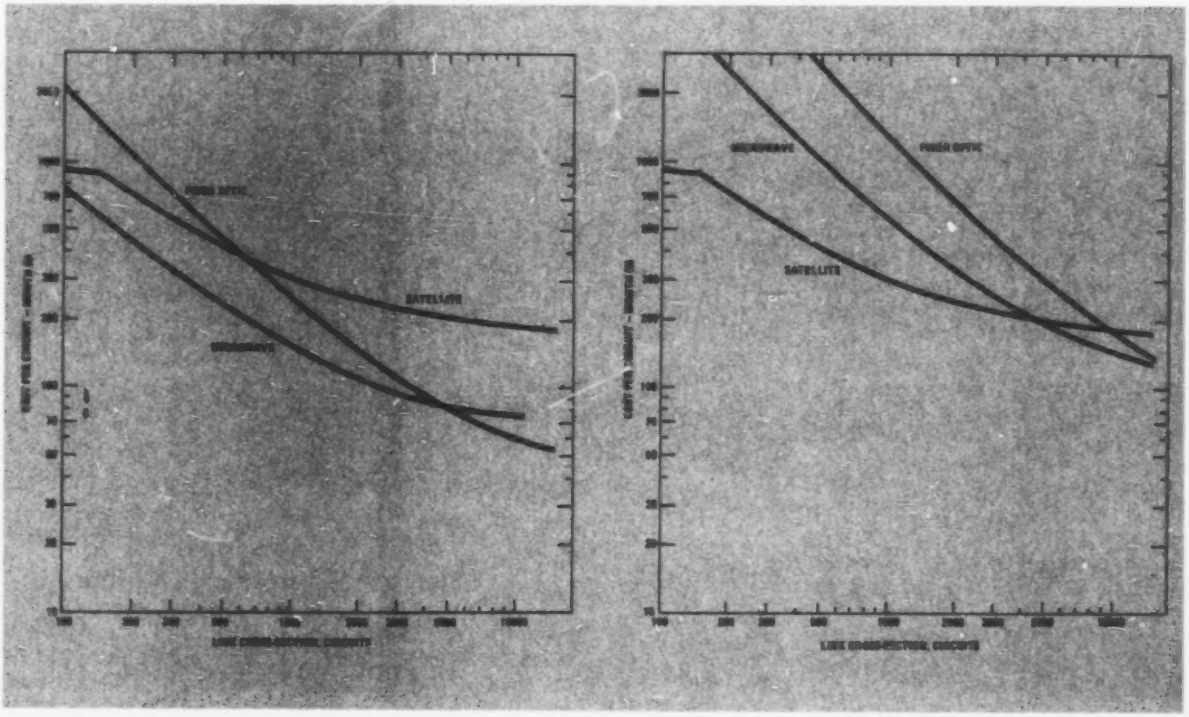

FIG. 9 *Cost per circuit—month vs. link cross-section length = 500 km.*

FIG. 10 *Cost per circuit—month vs. link cross-section length = 3000 km.*

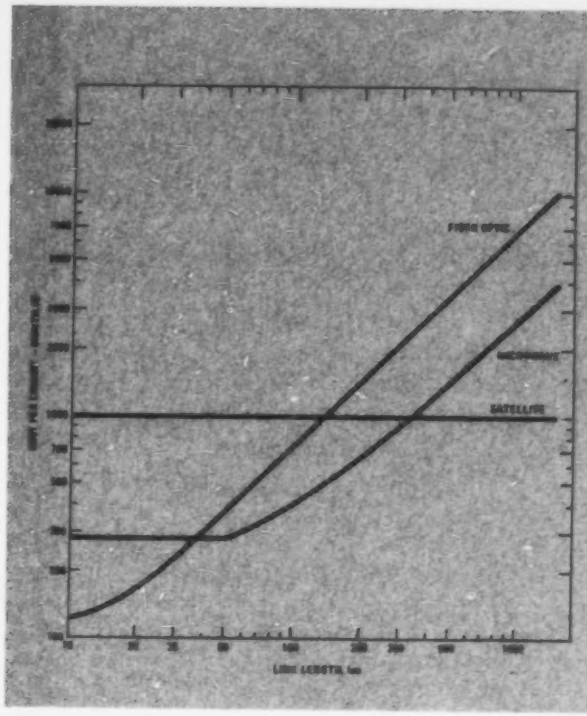

FIG. 11 *Cost per circuit—month vs. link length cross-section = 60 circuits.*

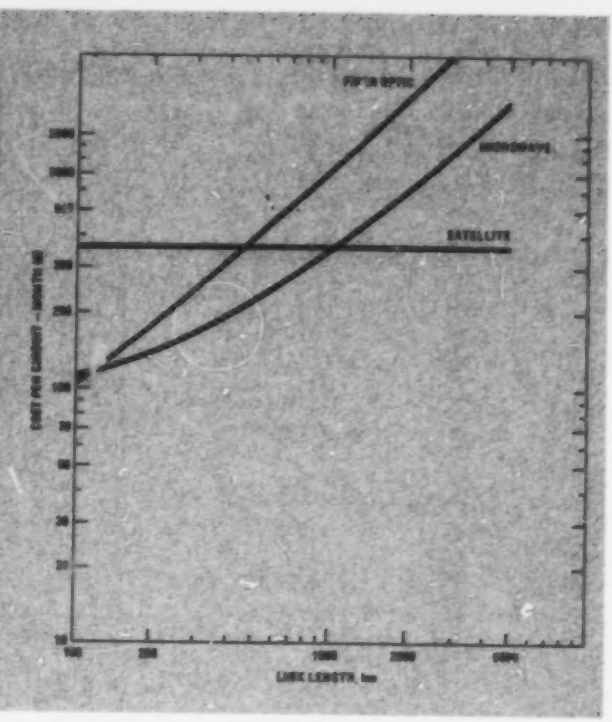

FIG. 12 *Cost per circuit—month vs. link length cross-section = 600 circuits.*

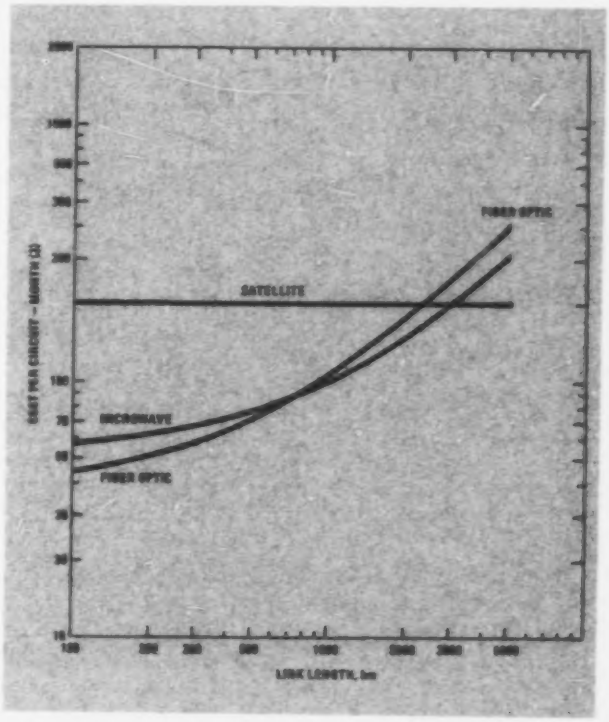

FIG. 13 *Cost per circuit—month vs. link length cross-section = 6000 circuits.*

nologies promise to bring the cost of satellite communications to a lower level, both in the near term and toward the end of the century.

Low cost earth station technology is an offspring in part of the boom in television receive-only earth stations. This boom has resulted in the widespread manufacture of inexpensive antennas in the 4 m to 7 m range, and the development of low cost field effect transistor (FET) low-noise amplifiers. The increased interest in satellite communications among corporate users which has lately been in evidence also has spurred manufacturers to offer inexpensive earth stations for corporate communications networks. These stations use single channel per carrier or narrow band TDMA access methods to allow transponder costs to remain low, because only a small fraction of the capacity of a transponder is used, while still providing demand-assigned capacity for a flexible system.

Hybrid, or multiple frequency band, satellites have a number of advantages in network and otherwise. Each earth station potentially has access to all other earth stations, regardless of their frequency of operation, provided that the frequency bands are interconnected on the spacecraft. Network expansion is facilitated, since an earth station system may be augmented by a station operating in any of the bands. This can be of particular benefit in avoiding interference with the terrestrial microwave environment or in using lower frequencies in locations where rain attenuation is a problem.

One form of hybrid satellite which is particularly efficient, and which may come into widespread operation in the late 1990s, is a large, multibeam communications platform. Such a satellite combines the benefits of multiple frequency bands, multibeam area coverage antennas and onboard switching to create a flexible and efficient facility. □

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Continued from page 94

management facilities lag behind a company's marketing and implementation efforts.

Back-up and redundancy. What happens if a cable break occurs under a street or microwave radios become misaligned atop a 40-story building? The organization should have a solid contingency plan that is tested often to ensure its reliability. Whether a least cost network is constructed that perhaps allows for somewhat degraded service or a specialized company is used, back-up plans are just as important as the primary network.

Business objectives. What will the company's information requirements be over the next few years? Does the network have the capacity and flexibility to grow and shift with the company's needs? Are some options too rigid or confining? The network should be capable of supporting projected as well as unexpected business demands.

Miscellaneous. Does the user have line of sight between locations? Will repeaters or reflectors be required? Are microwave frequencies available? What happens if a building is constructed in the midst of the company's microwave paths? Can the company use repeaters or reflecters to alleviate the problem? Will the landlord, if the building isn't owned by the company, permit the user to install microwave equipment? Are the environmental conditions right for the selected transmission media? The list goes on and on. However, these are the details that have to be checked to make the project work.

Costs. After a company has planned for all the contingencies outlined above, is the system still cost justified? Is the payback reasonable? Are there factors that override telecommunications-related costs? For example, the ability to expand the network quickly sometimes can mean the difference between acceptance and rejection of a new business venture.

There has been enormous progress in recent years in bypass technology, yet bypass is sometimes not as simple or feasible as a vendor's glossy literature often leads a potential user to believe. Competition and rising user interest have hastened the development and introduction of options by telephone companies.

Thus, when users begin to examine the options and all of the pitfalls of bypass seriously, the decision to pull the plug on the telephone company will not be an easy one. □

Continued from page 100

not completely sure what choices they have. But despite the screaming from the media, the situation is nothing near chaos. The newspapers and television commentators do not give the public enough credit for resourcefulness.

Donald Guinn, chairman of Pacific Telesis, made an excellent observation about the divestiture's effect on customers. "After all, these are the same people who've learned to use VCRs, automatic tellers and public transit systems," Guinn said. "Some have even learned how to fill out income tax forms and negotiate the freeways. Somehow I think we'll also learn how to order a telephone and get it fixed if it breaks."

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Contel is just one example in an industry that has turned itself inside out. A system designed to regulate franchised monopolies now faces the challenge of adjusting to a different set of circumstances. The question today is whether the traditional process is changing sufficiently to achieve an orderly transition to a competitive environment. The three basic truths about the American telephone industry, after all, have not changed. Universal service, affordability and reliability are as important as ever.

If any one of these three truths is threatened, the industry has a clear obligation to find ways to modernize and streamline the system so the public will enjoy the best of all worlds.

But moving beyond current controversies, everyone should remember that the industry's current environment has been brought on by its good fortune. The new technologies responsible for these changes are cutting the cost of sending messages and stimulating a much needed boost in telco productivity. Like the robot welders on auto assembly lines, competition and technology will benefit business and society as a whole, although maybe not each and every individual.

So far the industry is adjusting and so is Contel. The company has made its plans; in fact, all companies have made their separate plans. It looks like the industry may even know the rules.

But most importantly, the industry has committed itself to make it work. And it will. □

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